

INCREASING REGENERATION EFFICIENCY BY RECYCLING ALKANOLAMINES



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Abstract. This article aims to improve the efficiency of the gas purification process by determining the composition of the used alkanolamine solutions and regenerating them using the absorption method of gas purification from sour components.

Keywords: alkanolamine, monoethanolamine, diethanolamine, absorbent, desorption, ion exchange, filter, regeneration.

ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ РЕГЕНЕРАЦИИ ПУТЕМ ПЕРЕРАБОТКИ АЛКАНОЛАМИНОВ

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Аннотация. Целью данной статьи является повышение эффективности процесса очистки газов путем определения состава используемых растворов алканолламинов и их регенерации с использованием абсорбционного метода очистки газов от кислых компонентов.

Ключевые слова: алканоламин, моноэтаноламин, диэтаноламин, абсорбент, десорбция, ионный обмен, фильтр, регенерация.

ALKANOLAMINLARNI QAYTA TIKLASH ORQALI REGENERATSIYALANISH SAMARADORLIGINI OSHIRISH

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Annotatsiya. Ushbu maqolada gazlarni nordon komponentlardan absorbsiya usulida tozalash texnologiyasi ishlatiladigan alkanolamin eritmalarini ishlatilgan alkanolamin eritmalarini tarkibini aniqlash va ularni kombinatsiya usulida qayta tiklash orqali gazlarni tozalash jarayonini samaradorligini oshirishga qaratilgan.

Kalit so'zlar: alkanolamin, monoetanolamin, dietanolamin, absorbent, desorbsiya, ion almashinish, filtr, regeneratsiya.

Introduction. Let's consider one of the first processes carried out at Gas processing plant - the process of cleaning gas from sour compounds (harmful gases). Among the sour compounds in hydrocarbon raw materials, the most common aggressive and corrosive "harmful substances" are sulfur compounds, which include hydrogen sulfide and carbon dioxide, which reduce the heat of combustion of hydrocarbon gas.

Purification of hydrogen sulfide and carbon dioxide compounds with aqueous solutions of amines is the most widely used method with a history of more than fifty years. The most commonly used absorbent liquids used in the gas purification process from H_2S and CO_2 are (absorbent) ethanolamines: monoethanolamine (MEA), diethanolamine (DEA), triethanolamine (TEA), diglycolamine DGA), diisopropanolamine (DIPA), methyldiethanolamine (MDEA). When ethanolamines interact with acidic compounds in the gas, they form chemical compounds, which are easily regenerated when the temperature rises and the pressure decreases.

Literature analysis and methods. Correct selection of the absorber is the main task in cleaning natural gas from H_2S , COS, CS_2 , RSH. The correct selection of the absorber not only increases the quality of the product gas, but also reduces the energy and metal consumption of the equipment and helps to protect the environment in gas processing plants.

Despite the variety of gas purification methods, the absorber must meet stable general requirements: the absorber must have a high absorption capacity of acidic components, despite their content in the gas being in a large interval; the partial pressure of the absorber should be low, because its

loss in the process is reduced; for good contact with gas, the viscosity of the absorbent should be low; should be insoluble in hydrocarbons; should be neutral to hydrocarbons and inhibitors; low corrosion activity; resistant to oxidation and thermal decomposition; do not react with various compounds; stable to the formation of foam; the boiling point of the absorber should be lower than that of all components. It should be noted that the presence of polyethylene polyamines in the composition of the used alkanolamines increases the viscosity and foaming properties of the solutions along with extinguishing the operational activity of absorbents. For this reason, it is necessary to separate the thermal degradation products of amine from the maximum solution composition.

The combined recovery of alkanolamines was carried out using MDEA and DEA solutions over bentonite, followed by activated carbon and ionite. Although the technology of this method is expensive, it is considered highly effective:

Experiment 1. A column with a diameter of 20 mm and a height of 200 mm is filled with ampholyte in a volume of 100 cm^3 (by the length of the column ~ 5 cm) and a pre-measured amount (50-100 g) of DEA is added using a dropper.

The time of the procedure is 1-1,5 hours. There was no significant change in the color of the DEA solution passing through the column.

Experiment 2. This experiment is carried out in a column with a diameter of 20 mm and a height of 200 mm, in accordance with the experiment 1, but instead, ampholyte is replaced with activated carbon in the volume of 100 cm^3 (by the length of the column ~ 5 cm). The procedure takes 1 –

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1,5 hours. The color of the DEA solution passing through the column becomes clear.

Experiment 3. This experiment is also carried out under the conditions of experiments 1 and 2, replacing ampholyte and/or activated carbon, bentonite. The procedure takes 3 – 3,5 hours. The color of the DEA solution that has passed through the column becomes transparent.

Experiment 4. Both are carried in a glass column with a diameter of 20 mm and a length of 200 mm. Activated carbon with a layer height of 6 – 6,5 cm and ampholyte is placed at the same height. Alkanolamine is

barrier, and 100 cm³ of bentonite cleaned from the amorphous part. From the top of the column, a pre-measured (50 or 100 g) used DEA solution is dripped using a dropping funnel, and a receiving container is installed in the lower part.

Results. The used DEA working solution was completely analyzed by the combined method based on ionization and thermal methods.

From the results of the analysis, we can see a decrease in the amount of Na, Mg, K, Ca, Fe elements in the DEA working solution (table 1).

Table 1

Analysis results of purified technical DEA solution

The composition of the used DEA solution	According to the norm	Amount in solution, %	Amount after cleaning
Free DEA, %	30	22,37	22,0
Piperazine, %	4,0	3,0	3,0
Iron, mg/l	10,0-15,0	315	7,0-9,0
Bound DEA (tarnish substances), g/l	0,5-1,0	7,6	0,5-0,7
Heat resistant salts, %	0	5,2	0,02-0,03
Sodium (Na ⁺) salts, mg/l	0	63,1	0,01-0,02
Potassium (K ⁺) salts, mg/l	0	13,7	0,01-0,02
Formic acid, mg/l	50,0	667,3	36-41
Precipitable particles, mg/l	50,0	93	6.7

added dropwise. The passage time of alkanolamines is 2-3 hours.

Experiment 5. Bentonite, activated carbon and ampholyte were added to a vacuum column with a diameter of 20 mm in an orderly manner, using filter papers as a

The obtained data of table 2 shows that the working concentration of recycled ethanolamines decreases to 22% after purification, and it is recommended to compensate the lost amount by adding additional new absorbent to the system.

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The reduction of heat-stable salts in the regenerated alkanolamines from 5,2 % to 0,03 % proves that the combined process is effective while preventing foaming of the reagent in the system.

The amount of bound DEA (tar-like substances) in the working solutions of the absorbent has decreased from 7,6 g/l to the minimum concentration of 0,5 – 0,7 g/l, the amount of various additives should not exceed 1% in the normal operation of gas cleaning devices.

working properties of the purified DEA working solution also change dramatically, including: if the foamability of the solution approaches the norm and is equal to 2,3 cm/min, the stability of the foam (13 sec.) fully corresponds to the established norms, which is due to the reduction of surfactants that create stable foam in the solution, and the reduction of the surface tension coefficient caused by these substances at the same time, it allows to prevent the destruction of alkanolamines, which is

Table 2

Analysis of physico-chemical and working properties of purified technical DEA solution

Physical and chemical properties	Indicators of 30% (pure) DEA aqueous solution	Indicators of a 30% aqueous solution of technical DEA obtained by the ion exchange method
pH of the solution	10,8	10,4
Viscosity, sPz	2,6	2,8
Surface tension, din/cm	71,65	71,35
Absorption volume, mol/mol	0,40-0,44	0,40-0,44
Selectivity on H ₂ S, CO ₂ , %	95,0	95,0
Effervescence, cm/min	2,2	2,3
Foam stability, sec.	13	13
Amount of amine	21,4	21,3

From the analytical data in Table 2, it can be seen that the physicochemical and

intended for reuse.

At the same time, it is observed that the

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selectivity of the DEA working solution in terms of environmental pH, absorption volume of hydrogen sulfide and carbon dioxide is also restored, only the reduction

of the amount of amine can be observed, and it is recommended to eliminate this problem by adding unused absorbents.

Conclusion. The composition of

Table 3

Indicators of suspension cleaning in the method of ionization of DEA working solution

The amount of spent working solution is 15 l, the degree of purification is 69-75%

Composition of the used DEA solution	Unit of measure	DEA working solution	3-stage purified solution
Free DEA,	%	23,07	23,0
Bound DEA (Tarminous Substances)	%	6,93	0,5-0,7
Heat resistant salts	%	5,2	0,02-0,03
Amino acids	ppm	4233	92-97
Glycoliates	ppm	627	81-86
Acetates	ppm	439	73-79
Let them go	ppm	1648	102-108
Oxalate	ppm	498	112-116
Iron	mg/l	118	7,0-9,0
Precipitated particles	mg/l	93	6,7
Mechanical compounds	mg/m ³	779-1099	179-189
Sulfur preservatives	%	2,4-2,8	2,4-2,8
Resin compounds	%	2,5-3,5	2,5-3,5
Hydrates	%	3,5-4,0	3,5-4,0
H ₂ S	mg/m ³	15-17	15-17
CO ₂	%	2,1	2,1
Sodium (Na ⁺) salts,	mg/l	63,1	0,01-0,02
Potassium (K ⁺) salts,	mg/l	13,7	0,01-0,02
Formic acid, mg/l	mg/l	667,3	36-41

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working ethanolamine solutions used in the purification of natural gases from sour components using alkanolamines was determined.

Using the combination method, the content additives affecting the operational properties of the used alkanolamines are

based on the reduction of the amount of thermally stable salts, free elements, heavy organic substances, the physico-chemical properties of the purified alkanolamines affecting the operational properties, viscosity and foaming, surface tension are determined and reused.

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